# Science Data Validation Plan— MODIS Atmospheres Group

- **Summary of MODIS science objectives & data products**
- **MODIS atmosphere data products**
- **Team members & responsibilities**
- **Validation strategy, criteria, and plans**

MODerate-resolution Imaging Spectroradiometer (MODIS)

- **NASA, EOS AM & PM series**
  - **launches 1998, 2000, 2004, 2006**
  - **705 km polar orbits, alternating descending & ascending (10:30 a.m. & 1:30 p.m.)**

- **Sensor Characteristics**
  - **36 spectral bands ranging from 0.41 to 14.385 μm**
  - **cross-track scan mirror with 2,330 km swath width**
  - **Spatial resolutions:**
    - » **250 m (bands 1 - 2)**
    - » **500 m (bands 3 - 7)**
    - » **1000 m (bands 8 - 36)**
  - **2% reflectance calibration accuracy**
  - **onboard solar diffuser & SDSM**
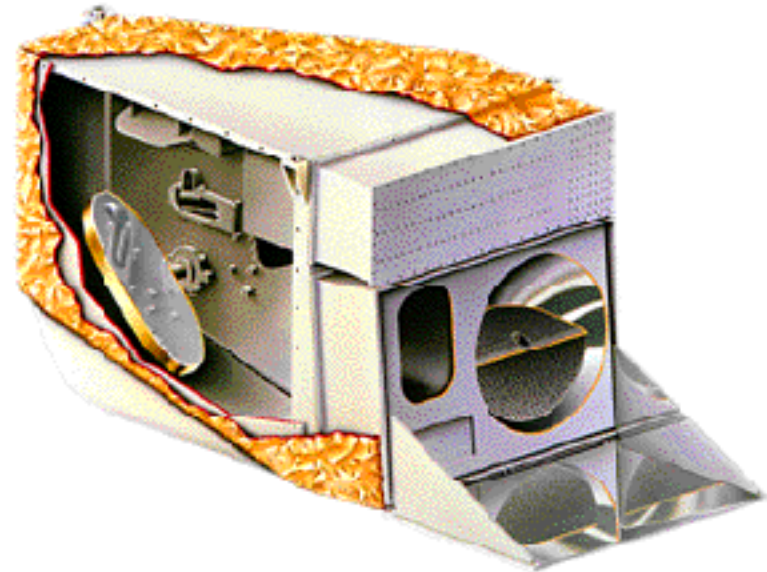
MODIS Atmosphere Products

- **Cloud mask for distinguishing clear sky from clouds**
- **Cloud radiative and microphysical properties**
  - **Cloud top pressure, temperature, and effective emissivity**
  - **Cloud optical thickness, thermodynamic phase, and effective radius**
- **Aerosol optical properties**
  - **Optical thickness over the land and ocean**
  - **Size distribution (parameters) over the ocean**
- **Atmospheric profiles of moisture and temperature**
- **Column water vapor amount**

Atmosphere Team Members

- **Michael King (Si-Chee Tsay)**
  - **Cloud optical thickness and effective radius**
  - **Thermodynamic phase (post-launch)**
- **Yoram Kaufman**
  - **Aerosol properties over the land**
- **Didier Tanré**
  - **Aerosol properties over the ocean**
- **Paul Menzel (Steve Ackerman)**
  - **Cloud mask**
  - **Cloud top properties**
  - **Temperature and moisture profiles**
- **Bo-Cai Gao**
  - **Column water vapor & cirrus detection**

Validation Strategy

- **Field experiments for pre-launch and post-launch validation**
    - **Research program**
    - **MODIS-specific validation campaigns**
- **Coordination with ground-based networks to optimize resources**
    - **Continuous basis at specific locations around the globe**
- **Wide variety of atmospheric conditions**
    - **Arctic stratus in the summertime arctic**
    - **Multi-layer cloud systems in the polar night**
    - **Aerosol properties over the ocean and several land surface covers**
    - **Column water vapor under both humid and dry conditions**

Field Campaigns

- **Research Program**

Mission	Dates	Responsible Team Members	Primary Purpose
SUCCESS	April-May 96	Tsay, Ackerman	cirrus cloud properties
TARFOX	July 96	Tanré, Kaufman	aerosol over the ocean
MOBY	August 97	Menzel, Ackerman	cirrus clouds and atmospheric correction over the ocean
SCAR-C	September 97	Kaufman, Remer, Menzel, Prins	fire detection and properties
FIRE III	April-June 98 August 98	King, Tsay	arctic stratus clouds over sea ice
LBA	September 99	Gao, Menzel, King, Tsay	tropical clouds and biomass burning

Field Campaigns

- **MODIS**-specific validation campaigns

Mission	Dates	Responsible Team Members	Primary Purpose
ARM	Sept 98	Menzel, Ackerman	periodic flights over Southern Great Plains
California	July 99 Dec 99	King, Platnick, Tsay	marine stratocumulus and valley fog
Mid-Atlantic	Aug 99	Kaufman, Tanré, Remer	water vapor, aerosol optical thickness & size distribution
Gulf of Mexico	Jan 00	Menzel, Ackerman	clear sky and cirrus clouds, plus sediment outflow from estuaries biomass burning
California & NW	Sept 00	Kaufman, Remer, Prins, Tanré	fire detection and smoke aerosols

Primary Sensors

- **ER-2 Aircraft**
  - **MODIS Airborne Simulator (King et al. 1996)**
  - **High-spectral resolution Interferometer Sounder (Smith et al. 1995)**
  - **Cloud Lidar System (Spinhirne et al. 1989)**
  - **AirMISR (currently under development)**
- **University of Washington CV-580**
  - **Cloud Absorption Radiometer (King et al. 1986)**
  - **Aerosol and cloud microphysics probes**
    - » **CN and CCN spectrometer**
    - » **aerosol and cloud drop size distribution**
    - » **liquid water content and effective radius probes**
    - » **ice particle counter**
  - **Nd:YAG monostatic lidar system**

Ground-based Networks

- **Selected ground-based networks**

Measureme	Location	Responsible Team Members	Primary Purpose
AERONET	US, Japan, South America, Africa, Europe	Holben, Kaufman, Tanré	aerosol optical thickness & columnar size distribution
ARM	Oklahoma, Alaska, WTP	Menzel, Tsay Remer	cloud base height, sky radiance, temperature & moisture
ECLIPS	selected sites and times– worldwide	Menzel, Ackerman	cloud base height statistics
AEROCE	multiple island locations– worldwide	Prospero, Kaufman, Tanré	aerosol hydroscopicity, size, scattering & absorption coefficients

Validation Criteria

- **Overall approach**
  - **Collocation with higher resolution aircraft data**
  - **Ground-based and in situ observations**
  - **Intercomparison with other AM-1 platform instruments**
    - » **MISR and MODIS for aerosol optical thickness**
    - » **ASTER and MODIS for cloud mask in polar regions**
  - **Focused and short field deployments**
    - » **winter deployment over the Great Lakes, Hudson Bay, sea ice, and lake ice (based in Madison, WI)**
    - » **summer deployment over the ocean, mountains, and desert (based in Mountain View or Dryden)**
    - » **post-launch ER-2 deployment over the SGP ARM/CART site in Oklahoma, together with ground-based sondes, AERI, microwave moisture measurements, lidar, radar, and whole sky camera images**

Sampling Requirements

- **Availability of MODIS-derived data products globally from AM-1 and PM-1 will enable scientists, worldwide, to provide feedback and validation information that will enable improvements in retrievals**
  - **Not possible for small MODIS science team to assess products under all conditions worldwide**
  - **Nighttime retrievals will be especially difficult for aerosol and some cloud properties**

- **Seasonal statistics and trends will be monitored to assess unusual changes in selected geographic and climatologically significant regions**

Pre-launch Activities

- **Data sets already in hand for algorithm development**

Campaign	Sensors	Responsible Team Members	Primary Purpose
ASTEX	MAS, CLS, CAR, microphysics	King, Tsay, Wang	marine stratocumulus
SCAR-A	MAS, CLS, CAR, AVIRIS, AERONET	Kaufman, Remer, King, Menzel	aerosol properties, surface BRDF
MAST	MAS, CLS, CAR,	Platnick, King	marine stratocumulus
SCAR-C	AVIRIS, MAS, AERONET	Kaufman, Remer, Prins	smoke, clouds, & radiation
ARMCAS	MAS, AVIRIS, CLS	Tsay, King, Platnick, Ackerman	arctic stratus clouds, BRDF of tundra & sea ice
SCAR-B	MAS, AVIRIS, CAR, AERONET, microphysics	Kaufman, Remer, King, Tsay, Prins, Menzel	biomass burning, surface BRDF

Pre-launch Activities

- **Data sets to be acquired between now and launch**

Campaign	Sensors	Responsible Team Members	Primary Purpose
SUCCESS	MAS, CLS, HIS, AERI	Ackerman, Tsay	mid-latitude cirrus, cloud over continents
TARFOX	MAS, LASE, CAR, AVIRIS, AERONET	Tanré, Kaufman, Remer, Tsay	sulfate aerosols over the ocean
MOBY	MAS, AVIRIS, AERONET	Menzel, Ackerman Prins	cirrus clouds & atmos. correction over ocean
SCAR-C	MAS, AVIRIS, AERONET	Kaufman, Remer	smoke-cloud interactions
FIRE III	MAS, CLS, CAR AERONET,	King, Tsay, Ackerman	arctic stratus clouds over sea ice, surface

Other Pre-launch Activities

- **Operational surface networks**
  - **Selected data from the SGP ARM site is archived daily at the University of Wisconsin**
  - **Ground-based sunphotometer/sky radiometer data from AERONET are archived every 30 minutes at Goddard Space Flight Center**
    - » **Spectral aerosol optical thickness and size distribution derived**
    - » **Uniform data reduction software used for this worldwide data collection network**

- **Satellite data**
  - **Pre-launch satellite data include AVHRR, HIRS, and GOES data for field experiment support and validation**
    - » **Data are archived at the University of Wisconsin**
    - » **Selected data sets for selected experiments archived at various DAACs (LaRC, GSFC) and the Naval Postgraduate School (MAST)**

Post-launch Activities

- **Validation campaigns Atmosphere Group plans on participating in**

Campaign	Sensors	Responsible Team Members	Primary Purpose
FIRE III	MAS, CLS, AirMISR, HIS, microphysics	King, Tsay, Menzel, Ackerman	arctic stratus clouds over sea ice
LBA	MAS, CLS, AirMISR	King, Tsay, Menzel, Platnick, Ackerman,	tropical cirrus clouds & biomass burning

Note: Status (and timing) of INDOEX not yet decided

Intercomparisons

- **Cloud Mask**
  - **The MODIS and ASTER cloud mask will be compared in polar regions**

- **Cloud Properties**
  - **Intercomparisons of thermodynamic phase derived from at-launch thermal algorithm and post-launch solar algorithm will be made during the day in a wide variety of conditions**
  - **Comparison between MODIS, CERES (SSF) and MISR cloud products (AM-1) should yield evidence of inconsistency in assumptions**
    - » **GLI will be an additional cloud mask and cloud property data set after its launch on ADEOS-2 in 1999**
  - **Cloud top altitude derived from MISR stereo imagery will be compared to MODIS-derived cloud top altitude (pressure) which is based on CO_2 slicing, a very different technique applicable both during the day and night**

Intercomparisons (continued)

- **Aerosol Properties**
  - **Intercomparisons of aerosol optical thickness derived from MODIS and MISR will be intercompared over the surface AERONET sunphotometer/sky radiometer sites worldwide (approximately 60 different locations)**
- **Precipitable Water**
  - **Precipitable water will also be compared between MODIS and the ground-based Cimel sunphotometers in the AERONET**

EOSDIS

- **Intercomparisons between various field experiments, surface sites, and international partner feedback will be coordinated to test refinements of individual algorithms in the Team Member's Computing Facility**

- **Where multiple algorithms are affected, further refinement will take place with periodic updates to the Team Leader Computing Facility, where a whole month of data will be processed using the revised algorithm**

- **Routine data products will be available to the global scientific community through EOSDIS**

- **Results from field experiments and validation exercises will also be made available to the international scientific community through EOSDIS, as are MAS data currently**